Swim Positioning and its Influence on Triathlon Outcome

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ABSTRACT

Int J Exerc Sci 1(3) : 96-105, 2008. Questions have been raised regarding which of the three legs of a triathlon influences the final finishing position. Some coaches subjectively believe that the swim and run are more important than the cycle, especially since the introduction of drafting during the cycle. This study analysed race position shifts between each of the three disciplines to assess the importance of the swim finish position and final finish position during draft legal Olympic distance triathlon events. Ten male and 10 female triathlon world cup events during one season were analysed. The results suggested that the triathlon swim leg is important because the winner exited the water in the first pack in 90% of elite male and 70% of elite female races. Correlations were also derived from finishing order for the whole triathlon and a finishing order that included the swim only, cycle only or run only time. For men, the average correlations for final finishing order with each of the swim, cycle and run, respectively, were 0.49, 0.67 and 0.86 and for the women; average correlations were 0.39, 0.67 and 0.85. Hence, this indicated that it was important to exit the water in the first pack and run well after cycling to achieve a successful final finishing position.

KEY WORDS: Swim performance, draft legal cycle, running, triathlon

INTRODUCTION

In non-drafting triathlon the swim portion is considered to play a less important role in determining final finishing position. Correlations between swim times and overall times are much lower or not significant when compared with correlations of cycle or run times with total times (4, 13, 20). This could be due to the different time durations of each individual discipline as a proportion of the total event time. For example, the 1500 m swim takes approximately 20 min to complete, the 40 km cycle around 60 min, and the 10 km run approximately 35 min, representing a total time of just below 2 h for males and just above 2 h for females. Hence, approximately 18% of the total time is accounted for by the swim, 52% by the cycle and 30% by the run. Landers et al. (15) and Zinkgraph et al. (21) used other methods, such as rank order correlation, to define the importance of each discipline and have reported roughly equal contributions of swim, cycle and run with final finishing position.

Elite level triathlon is conducted in a draft legal format during all disciplines. This allows athletes to 'shield' themselves from air resistance behind other competitors which can reduce the energy cost of cycling by up to 30% (6). In non-drafting events, triathletes are not permitted to ride within 7 m of their competitors unless they are passing. The subjective views of coaches and athletes, is that the swim is just as if not more important during draft legal events than reported in previous studies.

These draft legal events make it difficult for triathletes to change position between packs during the cycle portion as a group of cyclists can travel at a greater speed than an individual rider. Research has shown that, after cycling, there is a decrease in efficiency, or greater oxygen cost of running when compared with only running (5, 7-8, 12, 14) and when drafting is permitted, there is less decrement in run performance (9-10, 12). Thus, by drafting one can conserve energy for a faster run, increased cycle speed, or a combination of both.

In an attempt to clarify the matter further, the first part of this study sought to determine the importance of being placed in the first pack of swimmers out of the water in relation to the overall finishing position of a draft legal triathlon. The second aim was to characterise the importance of packs during the swim and cycle disciplines, and the relative importance of each discipline on final race outcome. It was hypothesised that the finish position of the swim portion of a triathlon was important, to the extent that exiting the water with the first pack of swimmers can determine the final finishing position in draft legal events.

METHOD

Sample

Results from 20 International Triathlon Union (ITU) World Cup Races held during the 1999 season were collected via the ITU website (www.triathlon.worldsport.com) for analysis. Permission to use results was obtained from the ITU. The results included both males and females separately for 10 events each. These twenty draft legal events were conducted in eight countries over the Olympic distance of a 1.5 km swim, 40 km cycle, and 10 km run.

Data Analysis

After data collection, triathletes were categorised according to the pack of swimmers from which they exited the water. Split times for each triathlete, from each event, were entered into the Mathmatica program (Mathmatica 2000, Wolfram Research, Inc., Champaign, IL, USA). Mathematica (16) was used to conduct all calculations, as a direct calculation tool to determine means and standard deviations, and as a modelling and simulation environment to determine the possible influence of swimming exit position on final race outcome.

In order to define each group, a minimum separation time between triathletes was required. That is, if a swimmer was more than 'x' seconds in front of the following swimmer, that was deemed to be the termination point for that pack. The subsequent swimmer was considered the leader of the next pack. Using Mathmatica, the minimum separation time between packs was varied from 2 s to 6 s (i.e. 2, 3, 4, 5 & 6 s) and the subsequent groupings were analysed. The size and number of groups were calculated for each event and an average calculated for males and females separately.

Once minimum separation time was determined and the size and number of each packs were calculated, the importance of being in the first swimming pack to exit the water could be examined in conjunction with the final finishing position. An ANOVA was used to determine if any significant differences existed between the number of packs in each discipline for both male and female events ($p<0.05$).

The importance of the swim leg in triathlon competition was determined by recording the number of winners who came from the first pack of swimmers (pack1). The number of triathletes in pack1 who finished in the top ten was tallied and the percentage of pack1 swimmers to finish in the top 10 and the percentage of top ten places filled by pack1 swimmers were calculated to highlight the importance of being out of the water in the first pack. Conversely, knowing the percentage of pack1 swimmers to finish in the top 10 can reveal the probability of placing in the top 10 at the end of the race if an athlete is out of the water with the first pack, especially if the first pack is greater than 10.

Means and standard deviations of each discipline time were computed to determine where the most variation existed within the Olympic distance triathlon. Then, the percentage of the total discipline time, which the standard deviation represented, was calculated. An ANOVA was conducted to determine if the standard deviation percentages revealed any significant differences between disciplines ($p<0.05$).

Correlations were established between final finishing position and rank order for each of the swim, cycle, or run time. The position of the winner was ascertained after the swim for both males and females. This procedure was repeated for the top five and top 10 finishers in each triathlon, and the mean positions were reported.

RESULTS

Analysis of the variation of the minimum separation time between packs revealed 4 s to be the most accurate. A separation time of 2-3 s revealed a larger number of packs and subsequently smaller pack sizes of between 1 and 4 triathletes. No significant differences between pack size or number of packs exiting the water were recorded with separation times of 4, 5 or 6 s. Four seconds equates to a gap between competitors of approximately 5 m during the swim, 45 m of cycling and 20 m running. Therefore, 4 s was deemed a sufficient gap between triathletes to cause them to cycle in different packs and was used for the remaining sections of the study (Table 1).

Table 1. Number of male and female packs after the swim, cycle and run determined by a 4 s separation between athletes.

	Swim	Cycle	Run
Male	8.0	8.3	35.3^{ab}
Female	10.2	8.6	33.8^{ab}

Note: ^{a} = significantly different to swim $p<0.05$
^{b} = significantly different to cycle $p<0.05$

Table 2. Number of male and female triathletes out of the water in the first pack and finished in the top 10 during the 1999 Triathlon World Cup Season.

		Male			Female		
Location	Date	Finishers/ Starters	Triathletes in pack1	Top 10, pack1 triathletes	Finishers/ Starters	Triathletes in pack1	Top 10, Pack1 triathletes
Ishigaki, Japan	April 11	72/80	72	10*	68/71	4	3*
Gamagori, Japan	April 18	66/82	66	10*	63/69	2	2*
Sydney, Australia	May 2	na	na	na	40/52	3	3*
Kapelle-op-den Bos, Belgium	June 13	50/60	33	10*	na	na	na
Monte Carlo, Monaco	June 20	41/47	3	0	37/42	10	4*
Kona, USA	June 26	24/46	30	10*	20/27	4	4
Tiszaujvaros, Hungary	Aug 8	51/53	20	7*	39/46	1	1*
Corner Brook, Canada	Aug 15	32/41	2	2*	27/31	2	1
Lausanne, Switzerland	Aug 29	52/70	4	1*	39/49	2	1*
Montreal, Canada	Sept 12	67/76	67	10*	52/62	6	3*
Noosa, Australia	Nov 7	40/50	8	5*	25/30	5	2

Notes: * = event winner came from pack one

na = full results not available, thus have not been used in calculations. There are still 10 male and 10 female events

Raw data of those triathletes in the first pack of swimmers (pack1) and, subsequently, those who finished in the top 10 for each triathlon are in Table 2. The male races held in Ishigaki (Japan), Gamagori (Japan), Kona (USA) and Montreal (Canada) revealed no discernible differences between triathletes at the end of the swim leg. Based on a 4 s separation criteria, video analysis and race reports indicated that only one pack of swimmers emerged from the water and that same pack cycled together in these events. The results also show no differences between athletes at the end of the cycle, with all athletes entering the transition from bike to run together.

In two other men's races (Belgium & Hungary), the number of pack1 swimmers was greater than 10. Hence, it was not possible for all of the pack1 swimmers to finish in the top 10. Thus, a secondary

Table 3. Totals and percentages of the first pack of triathletes to exit the water and the relationship to final finishing position.

Sample	Nº races	Total Nº starters	Total Nº triathletes in pack1	% triathletes in pack1	Total Nº top 10 places filled by pack1	% top 10 places filled by pack1	% pack1 in top 10
Male	10	605	305	50	65	65	21
Male A	4	208	17	8	8	20	47
Female	10	479	39	8	24	24	61

Note: % = percent
Nº = number
Male A = male sample including only those which have pack1 swimmers < 10

analysis was undertaken which limited the sample to those races where pack1 included 10 or less triathletes (Table 3).

A total of 605 males and 479 females started in the 20 events under examination. In the complete male sample, 50% competitors exited the water in pack1 (Table 3). In the reduced male sample of four races, this included 208 starters, 8% of these exited the water in the first pack of swimmers. Also, only 39 of the 479 female starters exited the water in the first pack of swimmers over the 10 races.

Table 3 shows that, across four male races, 20% (8/40) of top 10 places were filled by triathletes exiting the water in the first pack. Of the male swimmers that exited the water in the first pack, 47% of these placed in the top 10. By comparison, if all 10 races were analysed, 65% (65/100) of the top 10 places were filled by pack1 swimmers. Of these swimmers that exited in the first pack, 21% (65/305) placed in the top 10.

Of the ten female races studied, 24% (24/100) of top 10 places were filled by triathletes exiting the water in the first pack of swimmers. Thirty-nine female triathletes in 10 races had been in the first pack out of the water and, of these, 24 (61%) finished the race in a top 10 position.

Across the 10 male races, 9 of winners came from pack1 swimmers. In the female events, 7 of the 10 winners had exited the water with the first pack of swimmers.

Table 4. Mean, standard deviation (sd) and standard deviation percentage (sd %) for male and female triathletes for swimming, cycling and running times (s) across 10 events.

	Male			Female		
	Mean (s)	sd	sd %	Mean (s)	sd	sd %
Swim	1082.0	16.06	1.48	1136.7	42.43	3.73
Cycle	3565.4	34.76	0.97[a]	3956.8	49.70	1.26[a]
Run	1929.3	56.05	2.91[ab]	2216.7	79.88	3.60[b]

Note: [a] = significantly different to swim $p<0.05$
[b] = significantly different to cycle $p<0.05$

The mean and standard deviations for all 10 events was calculated for both men and women in all three disciplines (Table 4). The greatest raw variation was noted for the run discipline followed by the cycle and swim. The percentage of the total time that the standard deviation represented was then calculated and this equated to a significantly higher percentage for both males and females in the swim and run, than in the cycle (Table 4).

Correlations between finishing order for the whole triathlon and a finishing order that only included the swim time, cycle time or run time are included in Table 5. Both the male and female triathletes showed a small correlation between swim time and final time, and a large correlation between the run time and final time.

Table 5. Correlation of final finishing position with the time of each of the swim, cycle and run disciplines.

	Swim	Cycle	Run
Male	0.49	0.67	0.86
Female	0.39	0.67	0.85

Note: all correlations are significant $p<0.05$

The mean position of the winner was calculated after the swim and cycle for both male and female events (Table 6). This was repeated for athletes finishing the event in the top 5 and top 10.

DISCUSSION

The findings of this study support the hypothesis that the finish position during the swim portion of a draft legal triathlon was important, to the extent that exiting the water with the first pack of swimmers can determine the final finishing. These results suggest that, by being a good swimmer and exiting the water in pack1, there is a greater chance of winning or placing in the top 10. That is 90% of male and 70% of female winners came from the first pack of swimmers to exit the water and that approximately half of the pack1 swimmers finished in the top 10. However, the reasons why this occurs are not clearly defined.

Also, the cycle discipline was shown to have the least influence on finishing position compared to swimming and running in both male and female events. This data supports the importance of the run in determining the final finishing position of draft legal triathlon.

These results are in contrast with previous non drafting research which suggested that the swim section was not important for determining finishing performance (4, 13, 20), or that all three disciplines carry the same weight (21). These investigations examined non-drafting events where the formation of packs during cycling was not permitted and would have influenced the final outcome in a very different way from a draft legal race. Perhaps the low correlation between swim time and total time is due to the relatively small amount of time spent swimming (18%) when compared with cycling (52%) and running (30%). However, considering the race position of an athlete at the end of each section rather than the total time can remove some of the bias of the amount of time spent in each discipline. Landers et al. when analysing a draft legal event used rankings for this purpose, but did not account for the formation of packs (15).

In the current study, the run was found to play a greater role in the final outcome than previously reported. Previous studies (4, 13, 15, 20-21) have only considered single events which does not allow for factors which could affect race outcomes in multiple events. For example, course design such as the number of hills and turns, environmental conditions such as water temperature, tides and air temperature, athlete preparation and training experience could influence race results.

It could be possible that other factors, such as position in the cycle or swim pack, play a role in the final outcome. Those who just 'sit in' the pack and do not contribute to the pace of the group by taking a 'turn' at the front will conserve more energy during the swim (1, 19) and cycle portion which may contribute toward a faster run time (9-10, 12). Those who dismount the bike earlier might create an advantage with a clear transition and the ability to start the run first. In a large pack of 50 triathletes, there could be 30 s between those who dismount at the front of the pack and those who are at the back of the same pack. This time difference could be increased during the transition, as those dismounting last must negotiate their paths around the other athletes throughout the transition (18).

In order to examine more closely the chances of finishing top 10 when pack1 exits the water with less than ten triathletes, the four male events where this occurred were observed independently. This result was not significantly different to the female results (47% v 61%) suggesting if pack1 has less than 10 athletes it is likely that members of that group will finish in the top 10. Further investigation is required to determine whether this is due to superior swimming skill, physiological (11) or anatomical (15) advantages which determine finishing position.

The data demonstrates that the women's times are more variable than those of the men. A consideration of dispersion measures (i.e. standard deviation (SD)) highlights the greatest variation during a triathlon occurs during the run. Despite the SD revealing a greater spread of scores during the cycle compared to the swim, when the SD is expressed as a percentage of the time spent in each discipline, the swim appears to play a greater role in determining the eventual winner in female events than it does in male events (male 1.48%, female 3.73%). However, both show significantly higher variation during the run compared to the cycle (male: run SD = 56.05 & cycle SD = 34.76; female: run SD = 79.8 and cycle SD = 49.70). That is, there is a larger percentage time variation in run and swim times than there is for cycle times.

Fatigue during the run could be a factor in determining final race outcome at this stage of the event (3, 5, 9). It may be that one can make up more places in the run and thus emphasises the importance of running performance. This suggestion is further confirmed by the significant correlation existing between run time and final time. Perhaps the relationship between competitors' running performance, as measured by run times, better predicts triathlon performance than swimming and/or cycling ability. This is supported by findings of Hue who found running performance in the laboratory is a valid predictor of draft legal triathlon finish time (11). Additionally, running time was a better predictor of final event time than was swimming but, this does not take into account the effects of packs. It could be that the more successful triathletes are those who can be at the front of the pack at the end of the cycle and have a faster transition. Thus, a faster cycle time may be the result of better positioning at the end of the cycle rather than cycling speed. These triathletes are leading going into the run and could have a psychological advantage over the chasing athletes and perform better. The factor of fatigue on final outcome requires further clarification. Another explanation could be that the better triathletes tend to show their superiority more towards the end of an endurance event simply because of better endurance capabilities. Millet and Bentley reported cycling peak power output (PPO) as a valid predictor of draft legal triathlon time suggesting that those athletes that can cycle at a lower percentage of their PPO may expend less energy prior to the run (17). The faster triathletes are those who have more energy reserved for the run which could be a result of expert use of drafting during the cycle and/or swim portions. Even if all triathletes have the ability to run the same time for 10 km, it is those who have used less energy during the previous two legs who will have the faster run after a swim and ride.

Research has shown that the physiology and biomechanics of running at the end of a triathlon and marathon are similar (9-10). It could be concluded that the reported correlation of run time with final finishing time is more related to the overall endurance ability than running skill. These correlation results highlight the importance of the run phase of triathlon and the need to be able to run effectively after prior activity (swim and cycle).

Although the winner's position throughout the event is worthy of note, it does not account for packs developed during the swim and cycle. As was noted some of the groups included the entire field at the end of the swim. These results reveal two things about the finishing position at the end of the swim. First, it is advantageous to be in the first pack exiting the water and, even if the initial pack is large, it is still important to attain a good position out of the water. This is possibly related to the tactical consideration of having a clear transition and ensuring a good position during the cycle (18). Secondly, it highlights that one does not have to be the best swimmer on the day but, rather, be placed in the first exiting group. Drafting has been shown to decrease a 400 m swim time by 3.2% (1) and if the athlete is able to conserve energy during the swim portion (2-3, 19) as well as the cycle portion (10), their chance of victory should increase.

The current study provides evidence that in order to have increased chances of winning an event, it is advantageous to be in the first pack out of the water, to increase the chance of cycling with the lead pack. The small number of groups after the swim and cycle disciplines and the large size of one or two of the most dominant packs suggest it is more important to expend less energy than one's competitors in the first two legs than it is to try and break away and gain a significant time advantage. This demonstrates the importance of packs during the swim and cycle in draft legal events.

In turn, the final finishing order was determined more by the run than either the swim or the cycle. However, the first two stages remain important as noted by calculations showing the top finishers moving sequentially through the field from phase to phase and the significant number of winners exiting the water in the first pack.

Athletes wanting to improve their finishing positions should swim well enough to be within striking distance of joining onto a big cycling pack and cycle well enough to stay in the lead pack and maximise drafting and optimise energy conservation. The need to improve one's running performance for the final portion after the two other disciplines is paramount. The minimum swimming and cycling performances required to do this could be more reliably ascertained by studying more triathlons and the conditions under which they were staged. In terms of talent identification, an athlete who is "just" a good swimmer and cyclist but an outstanding runner could be a better prospect than someone who is a good all around or better at swimming or cycling. The results of this study suggest that the final finishing order is determined more by the run than either the swim or the cycle yet, it is important to maintain proximity with the leaders through a good swim and exiting the water in the first pack.

These results confirm the subjective views of triathlon coaches, that the swim leg of the triathlon is important especially during draft legal events. In 9 out of 10 elite male races and 7 out of 10 elite female races, the eventual winner exited the water in the first pack. Results also showed that, if a small group of swimmers (less than 10) do break away during the swim, the possibility of these triathletes finishing in the top 10 is even higher.

These results have training implications for both swimming and running. A triathlete needs sufficient swimming skill to maintain a pace fast enough to swim with the front pack and not use excessive energy in so doing (19). There is also a need to develop a fast start and maintain that pace until a drafting strategy can be established during the swim in order to be positioned with the lead pack from the outset. Both aspects can be worked on relatively easily through traditional swimming training. Finally, the ability to run well 'off the bike' in order to improve a top 10 position into a winning position is not well understood and invites further investigation.

The greatest amount of variation in performance is found in running times when examining both the raw SD and the percentage SD. The swim leg appears to be the second most important discipline based on the large variation percentage SD in swim times. There are few changes in position during the cycle leg. Hence, it is importance to swim well to be in the first pack out of the water, maintain the position during the cycle and then be able to run quickly ‘off the bike’ in order for successful race outcome.

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